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One-Leaved Pine
Pinus cembroides Zucc. variety *monophylla* Voss

The tree shown in the illustration is known to botanists as *Pinus cembroides* Zucc. variety *monophylla* Voss. It is a variety of the Nut Pine that occurs in Arizona, California, and in Colorado. It reaches a height of 40 to 50 feet, and is remarkable in bearing but one leaf in each sheath, and is therefore sometimes known as the "one-leaved" pine. The leaves are 1 to 2 inches long, rigid, glaucous-green in color. The cone is broad-ovoid, $1\frac{1}{2}$ to 2 inches long, with a minute incurved prickle at the end of each scale.

The tree here shown was about 20 feet tall. Although it is now dead, successful cuttings from it have been made, and it will continue to be represented in the Arboretum.

The photograph was taken by Professor H. H. York.

RODNEY H. TRUE

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INJURY CAUSED BY ILLUMINATING GAS*

—BY—

DR. WILLIAM CROCKER

Director of the Boyce Thompson Institute for Plant Research

THE AUTHOR spoke of three groups of substances in illuminating gas that must be considered when one is dealing with the injurious and other effects of illuminating gas upon plants:

1. Substances readily soluble in soil water; cyanogens, especially hydrocyanic acid.
2. Substances not readily soluble in soil water, but rather readily condensed in oil; drip oils, especially members of the benzene and benzine series.
3. Gases of low solubility in soil water and not readily condensed in soils—methane, acetylene, ethylene, carbon monoxide, and other gases.

Illuminating gas escaping into a greenhouse or room injures plants through the presence of ethylene, and largely through the stimulating and anaesthetic action of the ethylene. The top of the plant is generally much more sensitive to ethylene than the root system, also ethylene is only slightly soluble in water and in plant tissues, so it does not accumulate and soon diffuses out of the plant tissue when the concentration outside is not maintained. For this reason it must be held around the plant continuously for some time to produce the physiological reactions. Hence, injuries to plants by ethylene occur mainly in enclosed places that hold the ethylene around the plant, and do not occur in the open where the gas is carried away readily by moving air currents.

Injury to trees by illuminating gas escaping into the soil in close proximity is largely due to the chemical substances that dissolve in the soil water or accumulate in the soil by condensation. Hydrocyanic acid is likely to be the main source of

* Abstract of part of a lecture given April 11, 1936, at the Morris Arboretum of the University of Pennsylvania.

injury to trees from leaks in gas mains. This is especially true with rapid temporary passage of gas through the soil. Even gas that is washed free from hydrocyanic acid leaves toxic material in the soil if a sufficient amount (20 to 24 times as much) is passed through the soil.

This is due to the second most toxic group of gases in the illuminating gas that accumulates in the soil, namely, the drip oils. The less volatile portion of the drip oils condenses in the gas pipes and remains there, or if some of it escapes it is limited to the soil in the immediate region of the leak. The less volatile portion of the drip oils is likely to be condensed in the soil near, as well as at some distance from, the leak. Both of the groups of substances mentioned above do injury by killing the roots and the lower parts of the stem. With a sufficient amount of the third group of substances in illuminating gas flowing through the soil for a long period, considerable injury may be caused. The injury results in intumescences or swellings on roots, distortion of root tips, yellowing of leaves, and leaf fall.

Since hydrocyanic acid is the highly toxic substance to trees from illuminating gas escaping into the soil, the power to reduce the injury to trees by gas is largely in the hands of the gas manufacturers. They can reduce tree injury from this source by so adjusting their processes that they will remove all the hydrocyanic acid. This will not, however, remove the necessity of great care in laying, maintaining, and frequently inspecting their pipe lines for leaks, for sufficiently large leaks can do injury due to the second group, or the drip oils, and even due to the third group, or the true gases. In fact, in very slow leaks, where the hydrocyanic acid accumulated slowly, it was found that some ethylene effects, such as downward bending and yellowing of foliage, showed up before the killing effects of hydrocyanic acid appeared.

After a leak has occurred that has killed trees, what is the proper treatment of the soil preliminary to replanting trees in the gassed soil? Hitchcock, Crocker and Zimmerman found three different factors that free the soil of the toxic residues from illuminating gas, (1) volatilization into the air, (2) transformation of the residues in the soil due to the action of the organisms, and (3) leaching residues out of the soil by water. Loss of toxicity from gassed soil was found to be rapid when the soil was stored in the open at temperatures from 20° to 80° C. Two to five days of exposure of small amounts of the soil under this condition eliminated most of the

toxic materials. If one wants to rid the soil rapidly of the toxic materials, it will be best to expose it frequently to the air by repeated shoveling or by leaching with a large volume of water.

The first two groups of substances mentioned above kill tissues, but otherwise have little effect that is of physiological interest. Certain compounds of the third group, namely, ethylene, acetylene, propylene and carbon monoxide, cause little if any necrosis, but show marked anaesthetic and stimulative effects. Offhand, one might expect an anaesthetic which tends to stop growth to lack the power to stimulate growth and even initiate growth in dormant cells. This, however, is not the case when proper concentrations of any one of the four gases mentioned above are applied to plants. This is well illustrated by the fact that while the proper concentration of any of these gases in the air will cause the growing parts of the stems of the tomato, sunflower, and other plants, to stop growing, at the same time it will induce growth on the upper side of the petioles, causing even those leaves that have ceased to grow to turn downward.

The four gases just named seem to have identical effects upon plants, but the minimum concentration in the air required to produce a given effect varies greatly with the four gases. The accompanying table shows the comparative effectiveness of the four gases in inducing responses in the sweet pea seedling and in the tomato plant:

GAS	Minimum parts per million needed to produce:	
	Declination in sweet pea seedlings, according to Knight and Crocker*	Epinasty in tomato petiole**
Ethylene	0.2	0.1
Acetylene	250.0	50.0
Propylene	1000.0	50.0
Carbon monoxide	5000.0	500.0

* 3 days' exposure used; ** 2 days' exposure used.

In inducing the downward-turning (epinasty) in tomato leaves, ethylene is 500 times as effective as acetylene and propylene, and 5000 times as effective as carbon monoxide. This table gives approximately the relative effectiveness of the several gases in producing all the plant responses mentioned.

The bending downward of the leaf of the tomato plant is very useful in detecting traces of illuminating gas in greenhouses and dwellings, traces of exhaust gas in garages, or traces of mine gas in mines. One part of illuminating gas to 400,000 parts of air at 20° C. will give about 45° bending response in leaves of the tomato in 48 hours. One part of ethylene to 10,000,000 parts of air will give a similar response. (Fig 1)

When a plant is exposed to various concentrations of any one of these gases, the amount of reduction in growth increases with the concentration of the gas until a concentration is reached in which it is completely stopped. This is the general effect of these gases on all plants and is a typical anaesthetic effect. The tip of sunflower and tomato stems is without motion during the exposure to 1 part of ethylene to 500,000 parts of air, and they recover this motion soon after removal from the ethylene.

Fig. 1

Response of Tomato Plants to different concentrations of illuminating gas in the greenhouse. Note the downward bending of the leaves (epinasty), increasing as the concentration of gas increases.

BIRDS OF THE ARBORETUM

THIS SPRING the migration, due to the exceptionally fine weather, was steady and continuous, and therefore made it difficult for the observer to obtain a representative list unless he could be in the Field each day. Particularly was this true in respect to the Warblers, as there were no storms to hold them back for several days and bring about the well known flight "waves." The clear, bright nights enabled the small birds to seek their way when and as they wished, and no doubt many species were not to be found in the Arboretum which otherwise would have been.

Of great interest was the large number of Cowbirds which were found in groups of their own and also mixed in with flocks of robins and starlings. None were seen associated with Red-wings. Never before has the writer had the privilege of observing so many together in such a limited area. Ospreys flying over this district are not rare but it is unusual for one to fish in such a small creek. An amusing incident was caused by a starling fighting a gray squirrel away from its nesting hole. The bird won the struggle by darting at the squirrel each time it moved, and finally pecked it so hard on the rump the animal lost its grip of the bark and fell into a shrub about ten feet below.

Cutting the meadow grass has killed many Meadowlarks, Red-wings and Bobolinks and made impossible the nesting of numerous others. If this could be delayed several weeks in future years a great number of birds would be saved. It was at first a surprise to find so few birds in the woods, but upon consideration this is undoubtedly due to the lack of undergrowth. The scarcity of Oven-birds is owing to the same fact.

The following species were added to the list during the period from the tenth of March to the tenth of June, 1936:

American Bittern—Botaurus lentiginosus

An individual of this species remained in the small marsh bordering the backwater of the creek during the last week of April.

Turkey Vulture—Cathartes aura septentrionalis

One seen soaring high over the farm.

Osprey—Pandion haliaetus carolinensis

One was observed searching for fish in the creek where it flows by a corner of the farm. The bird passed from sight following the creek's course upstream.

Spotted Sandpiper—Actitis macularia

Only one was seen which is surprising. It was teetering along the bank of the creek by the woods.

Yellow-billed Cuckoo—Coccyzus americanus americanus

Three were found. Two in the woods and the other in the thick growth on the edge of the greenhouse garden.

Chimney Swift—Chaetura pelagica

This species was seen in groups of three or five flying over both Compton and Bloomfield.

Ruby-throated Hummingbird—Archilochus colubris

One was observed feeding on the fragrant flowers of the trees and shrubs along the upper brook.

Northern Crested Flycatcher—Myiarchus crinitus boreus

Individuals of this species were seen in both Compton and Bloomfield, wherever there are fair-sized groups of trees.

Eastern Phoebe—Sayornis phoebe

This familiar bird was found by the duck pond; on the upper brook by the cabin; along the creek in several locations, and by the mill race near the bridge and at the mill.

Barn Swallow—Hirundo erythrogaster

Seen in numbers sweeping over the meadows and perched on telephone wires.

Eastern House Wren—Troglodytes aedon aedon

Found in numbers everywhere but the meadows.

Catbird—Dumetella carolinensis

Seen in every thicket and group of closely planted trees.

Brown Thrasher—Toxostoma rufum

Only one observed and that was in a thicket on the border of the upper Japanese garden.

Wood Thrush—Hylocichla mustelina

Seen in each well-shaded nook and lane and the woods

Veery—Hylocichla fuscescens fuscescens

Two found; one in the Japanese garden by Hillcrest Avenue, and the other in the woods.

Red-eyed Vireo—Vireo olivaceus

Seen in numbers over whole area except the meadows.

Black and White Warbler—Mniotilta varia

Two seen in the woods.

Blue-winged Warbler—Vermivora pinus

One found in shrubs where upper brook joins the creek.

Nashville Warbler—Vermivora ruficapilla ruficapilla

One seen in trees by stone summer house.

Eastern Yellow Warbler—Dendroica aestiva aestiva

Three were observed; two in shrubs by the duck pond and the other in the orchard.

Myrtle Warbler—Dendroica coronata

Found in flocks and singly wherever there are trees and shrubs.

Blackburnian Warbler—Dendroica fusca

Two seen in trees by the garage.

Chestnut-sided Warbler—Dendroica pensylvanica

Six seen in trees by the garage.

Bay-breasted Warbler—Dendroica castanea

One observed in trees by the garage.

Black-poll Warbler—Dendroica striata

Almost as numerous as the Myrtle Warblers and well scattered throughout the area.

Yellow Palm Warbler—Dendroica palmarum hypochrysea

Three seen in shrubs by duck pond.

Oven-bird—Seiurus aurocapillus

Only one seen, which is remarkable, and that was in the woods by the cabin.

Northern Water-thrush—Seiurus noveboracensis noveboracensis

One seen in upper brook near duck pond.

Maryland Yellow-throat—Geothlypis trichas trichas

Several found by duck pond; along upper brook near the cabin and on the banks of the creek.

American Redstart—Setophaga ruticilla

Two seen in trees by the garage.

Bobolink—Dolichonyx oryzivorus

A large flock was found on the rolling meadows of the farm.

Eastern Red-wing—Agelaius phoeniceus phoeniceus

Observed in numbers on the meadows of both Compton and Bloomfield.

Baltimore Oriole—Icterus galbula

Two seen; one in the orchard and the other in the glade by the boathouse.

Eastern Cowbird—Molothrus ater ater

A surprisingly large number of this species was found. They were equally divided between the lawn adjoining the avenue of oaks and the lawn between the upper brook and the greenhouse garden.

Scarlet Tanager—Piranga erythromelas

One seen in the trees between the main building and garage.

Rose-breasted Grosbeak—Hedymeles ludovicianus

One found in the woods.

Indigo Bunting —Passerina cyanea

Three were seen; one in the trees by the stone summer-house, another on the edge of the woods and the third near the mill.

Red-eyed Towhee—Pipilo erythrophthalmus erythrophthalmus

Several were observed in and adjoining the avenue of oaks.

Eastern Savannah Sparrow—Passerculus sandwichensis savanna

One was seen on the farm in high meadow grass on the edge of planted strip.

Eastern Tree Sparrow—Spizella arborea arborea

One was found in an evergreen between the avenue of oaks and the upper brook.

Eastern Chipping Sparrow—Spizella passerina passerina

Numerous over the whole area except the meadows.

Swamp Sparrow—Melospiza georgiana

One seen by upper brook near cabin.

LEWIS MACCUEN SMITH.

DEATH OF MR. WILLIAM WARNER HARPER

Mr. William Warner Harper, a member of the Advisory Board of Managers of the Arboretum, succumbed to an attack of heart disease on December 18, 1935, in his sixty-eighth year, after suffering nearly two years from this malady.

Mr. Harper was born in Germantown. He held a position for a time with the Midvale Steel Company, and later entered the employ of Miller and Yates, nurserymen of Mount Airy. In 1891, he became connected with the Andorra Nurseries, then owned by Henry H. Houston, of Chestnut Hill. Four years later, he purchased the business that expanded rapidly under his management. He became, also, the head of other enterprises of a similar character at Towson, Maryland, at Columbus, Ohio, and at Paris, Kentucky.

He took an active part in the affairs of Montgomery County, serving as County Commissioner in 1914, later becoming president of the Board.

He was a member of the Pennsylvania Horticultural Society, and of other botanical organizations, also a trustee of the Tyler Arboretum at Media.

He took an active part in the civic and business life of the community, and served as a director of the National Bank of Germantown and of the Germantown Trust Company.

CORRECTION

Readers of the sketch of the life and ways of the tent caterpillar, that appeared in the July number of the Bulletin (No. 4), should know that the sketch was from the able pen of Professor Philip P. Calvert, of the Department of Zoology of the University of Pennsylvania. It is hoped that Professor Calvert may favor the Bulletin from time to time with more of these sketches of the life histories of our insect friends or enemies.

PLANT COLLECTING TRIP

IT HAS become a habit for members of the staffs of the Arboretum and of the Department of Botany of the University of Pennsylvania to devote the week following the close of the spring term at the University to the exploration of some part of the state of Pennsylvania not well known botanically, for the purpose of studying the flora in the field. Collections are made by members of the types of plants in which they are particularly interested, and the dried specimens are placed in the herbaria of the University and of the Arboretum. In general, specimens of trees and shrubs come to the Arboretum.

Eleven persons made the party that spent the last week in June in Pike and Wayne Counties. Travel was by the Arboretum bus. Somewhat over a thousand specimens were added to the collections, including several rarities. Geographical distribution with reference to latitude, to soil characteristics and to the glacial history, offered problems of study.

WINTER LECTURE COURSE

THE GENERAL SUBJECT of the winter lectures to be given at the Morris Arboretum during the coming winter months will be *"Flowering Trees and Shrubs."*

The first lecture will be given on December 12th, by MR. JOHN C. WISTER, on the subject of Lilacs.

Lectures will be given at 2.30 P. M. on the second Saturday of the month, at the Arboretum. Entrance by the Meadowbrook Lane gate. Further announcements will follow.

Foliage Days at the Arboretum

The Arboretum will be open to visitors from 9 A. M. until 5 P. M. on Saturday, October 17th and on Sunday, October 18th. It is hoped that the autumn colors may be at their best at that time. No admission cards will be required.